Pressure Prescription for Blood Flow Restriction Exercise

To the Editor-in-Chief,

We read with interest the article by Crossley et al. (1) investigating the relationship between blood flow restriction cuff pressure and blood flow during rest and exercise. The authors measured blood flow to reflect an "ischemic stimulus" across different arterial occlusion pressures (AOP), reporting that the ischemic stimulus induced by a nontourniquet cuff does not have a linear relationship with pressures between 30% and 80% AOP. They recommend using lower pressures (i.e., 40% AOP) to provide the same ischemic stimulus as higher pressures (i.e., 80% AOP). Although we agree that lower pressures may be more comfortable, we believe that methodological limitations may have led to erroneous conclusions. We wish to extend their discussion by addressing specific aspects of the study methodology.

This study emphasizes the importance of measuring limb occlusion pressure (LOP), which is the minimum pressure required for occlusion of all arterial vessels in a limb underlying a surgical-grade tourniquet cuff (2), rather than AOP. Measuring a superficial artery by Doppler ultrasound does not provide accurate and reliable estimation of LOP: by applying a nonuniform pressure over the superficial artery, blood flow in this artery can be restricted without similarly restricting blood flow in deeper arteries. Therefore, a percentage of occlusion in one superficial artery (e.g., 40% AOP) does not necessarily represent the same total ischemic stimulus at 40% LOP.

Doppler ultrasound was used to measure mean blood velocity and vessel diameter during end-diastole, with calculation of volumetric blood flow in the superficial femoral artery. Without measurement of total volumetric limb blood flow distal to the cuff, the total ischemic stimulus cannot be determined. Doppler method of calculating blood flow has limitations presenting possible sources of error. Considerable random error is attributable to measurement of the cross-sectional area and angle of approach (3), which can be minimized by repeated measurements and calculation of a mean. In addition, small errors in measurement of the vessel diameter (which changes during the cardiac cycle) result in large changes in cross-sectional area calculation and thus volume flow calculation (4).

The Hokanson cuff used in this study does not have stiffeners, and the bladder is not designed to encircle the entire limb. This results in nonuniform pressure applied to the limb circumferentially, nonuniform restriction of blood flow, and may affect measurement results. Using a surgical-grade tourniquet cuff to produce uniform pressure distribution around the circumference of the limb would more accurately reflect the actual pressure applied to the limb (5).

Finally, the authors use a measurement of blood flow at rest to make a conclusion on blood flow during exercise, which assumes that the resting measurements can be transferred to exercise. However, blood flow during exercise was only measured at 40% of resting and exercising AOP. Therefore, their conclusion that 40% AOP will provide a similar ischemic stimulus to 80% AOP during exercise is not supported by appropriate experimental data.

To conclude, we recommend that the authors' conclusion that lower pressures will provide a comparable ischemic stimulus to higher pressures should be interpreted with caution.

No conflicts of interest, financial or otherwise, are declared by L. H. J. M. has a financial interest in two companies that develop and commercialized blood flow restriction equipment.

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